Weatherwise

California's White Gold

Types of Solid Precipitation in Snowstorms

Record Low Temperatures

Midwinter Temperature Antics in the Black Hills

Polar Weather Flights

Vol. 1, No. 6, December 1948

"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE" — BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

COPYRIGHT, 1948, BY AMATEUR WEATHERMEN OF AMERICA

DAVID M. LUDLUM, *Director*
HANS H. NEUBERGER, *Technical Editor*
D. C. CAMERON, *Research Associate*
CHARLES A. FEDERER, JR., *Editor*
ROBERT E. COX, *Assistant Editor*
ERIC SLOANE, *Art Director*

A FORECAST SURVEY BY AMATEUR WEATHERMEN

IN A LETTER to the Amateur Weathermen of America, F. W. Reichelderfer, Chief of the U. S. Weather Bureau, wrote on October 13th:

"Our Pittsburgh office recently forwarded to us a copy of the Forecast Survey made by the Amateur Weathermen of Pittsburgh, which was published in the August-September issue of **The Weather Vane**. We believe that this survey was very worthwhile, for it gives an unbiased appraisal of the accuracy of official forecasts.

"Perhaps the AWA has plans for a program of verification surveys of official forecasts by local branches. If not, it occurred to me that you might care to encourage such activities by publishing a brief of the Pittsburgh survey in WEATHERWISE and mentioning that the Weather Bureau would be very much interested in being advised of the results of any such surveys. It seems to us that it would not be necessary for any local branch to conduct a continuous survey, but that representative results could be obtained by having different local branches make one- to two-month surveys in their cities about once a year.

"We would appreciate your comments on our suggestion. If the AWA decides to enter into such a program, we will be glad to co-operate by having our local offices make available data needed by those conducting the surveys."

The Pittsburgh forecast survey was made for eight weeks from July 4th to August 28th, this year. The forecasts cover a radius of 25 miles from central Pittsburgh, and the 30-hour forecast, current at 6:00 p.m., was used in the survey. Michael Hanselman was chairman of the survey committee of the AWP.

For the purposes of their analysis, the amateur weathermen classified the official forecasts into **direct** (unequivocal in description), **qualified** (with terms such as "chance of," "risk of"), and **modified** (allowing alternatives, such as "in the afternoon or evening"). In the 56 days, 47 direct forecasts proved 87% accurate, seven qualified forecasts scored 89.3%, and two modified forecasts were 87.5% correct, giving an overall average for the period of 87.3%.

On 33 of the 56 days the Weather Bureau was 100% right. The best seven consecutive days were July 12-18, with 100% on each day. The poorest seven days were August 17-23, with a 63% average. Days on which rainfall was predicted but did not fall numbered only three, but somewhere in the survey area unpredicted rain did fall on 10 days.

Although temperature was not included in determining the above percentages of accuracy, official Weather Bureau records (with one of 56 days missing) were used to check temperature predictions. On 22 days, both the predicted high and low were within two degrees of the actual temperatures. On only six days was the low prediction in error by more than four degrees, and on only 10 days was the high prediction incorrect by more than five degrees.

Vol. 1, No. 6 December, 1948

CONTENTS

California's White Gold—R. W. Gerdel ... 119
Types of Solid Precipitation in Snowstorms—Vincent J. Schaefer ... 124
Record Low Temperatures ... 125
Midwinter Temperature Antics in the Black Hills—D. C. Cameron ... 126
Polar Weather Flights—B. C. Haynes ... 128
News Notes ... 133
Amateur Weathermen of America ... 134
Workshop for Weathermen—Charles A. Laird ... 136
551.5 ... 138

Cover: A typical meteorological substation used in several western snow laboratories. The Stevens Type Q recording precipitation gage has a reservoir with double the capacity of the chart. The reservoir receives a 12-inch charge of 33-per-cent calcium chloride and has a residual precipitation capacity of 12 inches. Maximum and minimum thermometers and a hydrothermograph are located in the instrument shelter. A permanently marked snow course is also a feature of such a substation. Photo by Cooperative Snow Investigations, U. S. Weather Bureau. (See page 119.)

WEATHERWISE is published bimonthly by Amateur Weathermen of America, Franklin Institute, Philadelphia 3, Pa. Membership in the AWA costs $3.00 per year, of which $2.00 is for a subscription to WEATHERWISE and $1.00 for general dues, for members in the United States and possessions and in the armed services. Add 50 cents per annum for postage to Canada and all countries of the Pan-American Postal Union; add $1.00 for all other foreign countries. Make checks and money orders payable to Amateur Weathermen of America. Send notice of change of address three weeks in advance, giving old address. General, circulation, and advertising offices: Franklin Institute, Phila. 3, Pa.

The photograph on the left was taken on March 31, 1948, from Emigrant Gap on U. S. Highway 40, and shows the snow cover extending from about 4,500 to over 8,500 feet. The other picture, taken from the same site, was made on May 11th to show the large amount of snow remaining above 6,000 feet. By this time, maximum temperatures in the valley were above 90° and occasionally above 100°, and the snow-line recession is vividly illustrated. Note the filled storage reservoir in the center of the scene. U. S. Weather Bureau photographs.

California's White Gold

R. W. GERDEL, TECHNICAL SUPERVISOR
COOPERATIVE SNOW INVESTIGATIONS, U. S. WEATHER BUREAU

ONE HUNDRED YEARS AGO, gold was discovered in California. Thousands of forty-niners struggled and even died in the deep snows of the High Sierra, in their rush across plains and mountains to reap the harvest of yellow metal. Today, these vast and deep snow fields are the white gold of California, worth almost as much in a single year as all the precious yellow metal ever removed from these mountains.

Through the central portion of California extends a long narrow valley known as the Great Central Valley. It is 500 miles long and 50 miles wide, extending from Mt. Shasta on the north to the Tehachapi Mountains in the south. Eastward, and rising to 14,000 feet, are the Sierra Nevada and the Cascade ranges, and westward, the lower Coastal Range.

The climate of California is characterized by wet winters and dry summers. On account of the protection afforded by the vast rim of mountains, the Great Central Valley has a relatively dry climate throughout the year. Average annual precipitation in the valley varies from six inches in the south, near Bakersfield, to about 20 inches in the northern portions. In spite of the deep alluvial and remarkably fertile soils of the Great Central Valley, only a small portion could be cultivated, and then only as dry-land farming, if the white gold were not replenished each year along the westward slopes of the Sierra and Cascade ranges.

Winter storms in these mountains frequently last for five or six days, and a single storm may produce in excess of six feet of new snow above 5,000 feet elevation. Accumulative snowfall for the winter season, as shown by snowfall at Donner Summit, may exceed 600 inches (see next page). The newly fallen snow settles rapidly; but it is a rare winter when there is less than 100 inches of snow on the ground above 6,000 feet, while a depth in excess of 200 inches is common.

Precipitation in the Coast Range, due to its lower elevation, is much less than in the Sierra Nevada. But more than nine tenths of the runoff which supplies water to the valley originates in the Sierra and Cascade ranges, primarily from storage in the deep snowpacks at high elevations. Average annual precipitation varies from about 80 inches, in the northern Sierra and Cascade ranges, to 35 inches in the southern Sierra. As shown by the table, the average winter precipitation

(October to April, inclusive) at Soda Springs, California, at an elevation of 6,750 feet, for the period 1890 to 1946, was 43.77 inches.

AVERAGE MONTHLY PRECIPITATION
SODA SPRINGS, CALIFORNIA
6,750 FEET 1890 - 1946

Month	*Inches*	*Month*	*Inches*
July	0.19	January	9.32
August	0.17	February	8.41
September	0.69	March	7.61
October	2.40	April	3.46
November	4.70	May	1.96
December	7.87	June	0.70
Yearly Average			47.48
Snow Season (October-April)			43.77

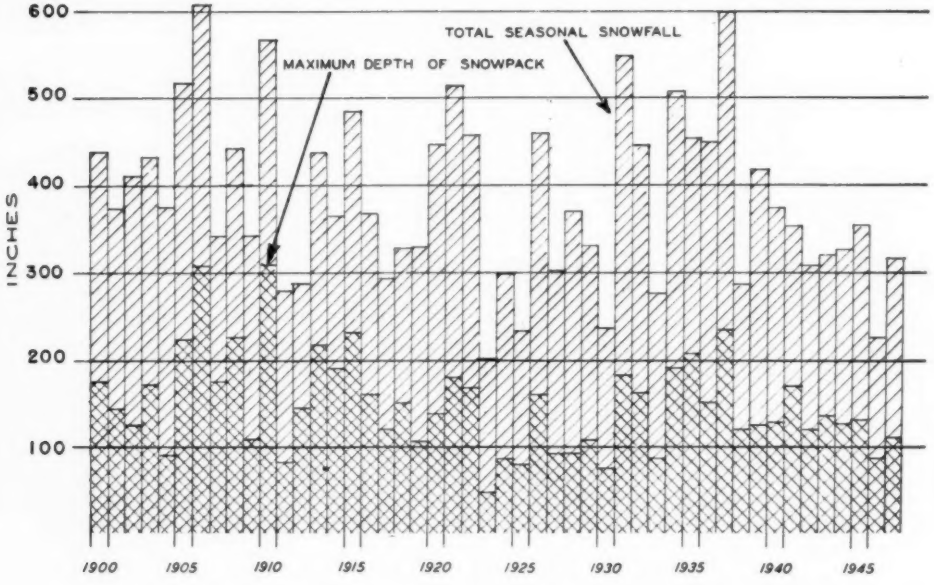
Almost all of this precipitation is stored as snow. During the spring and early summer, this deep snowpack is a reservoir of water for power, irrigation, industrial and domestic supplies. Over one half of the annual runoff into the valley streams occurs during April, May, and June.

Man constructs massive and expensive dams to store water but nature has supplied to California, and many other western states, vast storage reservoirs in the form of deep winter snows. Man controls the gates which release water from the artificial reservoirs. Nature, by means of meteorological forces, controls the valves which release water from the high mountain snowpacks.

By judicious use of natural and artificially stored runoff from the snow fields for hydroelectric power and irrigation, the Great Central Valley has become one of the greatest agricultural areas in the United States. Of the 11,500,000 acres of land comprising the valley floor of the Sacramento and San Joaquin rivers, 3,500,000 acres are under irrigation. The average income from the more intensively cultivated land, producing fruits, nuts, and vegetables, exceeds four hundred dollars per acre. The value of all farm produce and livestock from this great valley is a quarter of a billion dollars per year.

At present, storage reservoirs behind the great Shasta and Friant dams impound, for late summer use, less than one sixth of the average annual runoff in the major valley streams. Construction of more reservoirs, with suitable canals for diverting water to farm irrigation ditches, would make an additional 3,000,000 acres available for cultivation.

The cost of water for irrigation varies from $1.50 to $14.00 per acre-foot. An acre of snow in the mountains above 7,000 feet will



Snowfall and snowpack at Donner Summit, California, from 1900 to 1947. This chart was prepared by the Cooperative Snow Investigations.

A rotary snowplow clearing the Southern Pacific tracks after a heavy storm near the summit of Donner Pass in the Sierra Nevada mountains. Photograph courtesy Southern Pacific railways.

contain about three acre-feet of water at the end of the winter season. If economically distributed and used, the water from each snow-covered mountain acre is worth at least five dollars per year for agricultural purposes alone. If we capitalize this at three per cent, an acre of land in the high mountains is worth about $165.00. This value becomes much larger when we consider the many other duties of snow-melt water in the valley.

Duties of Snow-melt Water

Long before the water from the melting snow reaches the valley farms, it has served to produce hundreds of thousands of kilowatts of electricity to operate western industries. Great urban centers and industries demand a large share of the runoff. Sufficient water must flow through the river channels to insure navigable depths for ocean-going vessels 50 to 75 miles inland. Salinity repulsion is another important duty of the water from the melting snow fields; to prevent intrusion of saline ocean waters into the valuable, low-lying farm lands in the Sacramento-San Joaquin delta, a flow of fresh water amounting to almost 5,000 cubic feet per second must be maintained. This is almost one tenth of the 33,000,000 acre-feet average annual runoff of the two major streams.

It is not possible to place a monetary value on all the duties of water in an area like the Great Central Valley, or for that matter, in any of the other areas of the West where the entire economy of a state may be based upon the white gold in its mountains. A single unit of water from a melting snow field may produce hydroelectric power, domestic water, irrigation and industrial water supplies, and on its return to the river through sewage disposal it may serve to repulse salinity, float an ocean-going freighter, and cool condensers in great oil distilleries located in the delta area.

It is obvious that the estimated value of

five dollars per year for an acre of snow-covered mountain is highly conservative. Some agencies credit a snow-covered mountain with a yearly value as high as 40 dollars per acre. Actually, the snows of the West are priceless, for without them the keystones of modern civilization, industry and agriculture, could not exist.

Forecasting of Water Supplies from High Mountain Snow Fields

The extreme variation from year to year in the amount of water stored in the mountain snow fields is indicated in the snowfall and snowpack record for Donner Summit, California. The seasonal water equivalent of the snowpack at this station has varied between 17.8 inches and 68.7 inches during the past 40 years. Economic usage of meltwater from the snowpack requires that a forecast of seasonal water supplies be made.

Such forecasts help the private power companies to devise procedures for economical operation of their reservoirs. Public agencies, such as the Bureau of Reclamation and the Corps of Engineers, adjust the operational procedures for flood control and irrigation projects under their supervision in accordance with the seasonal forecast.

Farmers in the Great Central Valley adjust their crop plans to the amount of irrigation water which these forecasts indicate will be available. An indicated shortage of water, due to a light snowpack, means the conversion of many acres from rice, a crop requiring five acre-feet of water, to early or short-season vegetable crops which may be grown and harvested on an 18- to 24-inch supply of water.

As long ago as 1909, Dr. J. E. Church, of the University of Nevada, recognized the need for an inventory of the winter snowpack. His first efforts to survey the snowpack were made on Mt. Rose near Reno. By 1920, sufficiently satisfactory snow survey procedures had been developed to permit a fairly accurate forecast of water supplies for limited areas in the West. The far western states and several government agencies gradually increased the number of snow surveys and established forecasting offices. By 1935, the Soil Conservation Service began to co-ordinate the yearly snow survey data from the many private and public agencies. During the winter of 1946-47, more than 1,000 snow surveyors were employed in the western states. They traveled over 27,000 miles of ski trails and measured 1,000 courses at elevations from 3,000 to 12,000 feet in the Sierra, Cascade, and Rocky Mountain ranges.

From snow surveys near the end of February seasonal water supply forecasts are prepared as of March 1st. A limited number of supplemental surveys may be made late in March and a modified forecast issued as of the 1st of April. In California, the major

In the Cooperative Snow Laboratories, the tracing of movement of meltwater through the snowpack is determined qualitatively by means of water-soluble dyes. Quantitative measurements are made with a specially designed electronic moisture meter.

seasonal water supply forecast is based upon an April 1st snow survey of 271 courses.

Since the major seasonal water supply forecasts are based upon the 1st of March or 1st of April snow surveys, they are subject to considerable error. An early winter may have produced a deep snowpack and an early spring may have greatly reduced the water content of the pack by the time the snow surveys are made. Much of the seasonal water supply already may be on the way down to the valley, and difficult adjustment in the forecasts is required. A delayed winter, such as that of the 1947-48 season, when little snow fell before March 15th, but a greater than normal pack developed by April 10th, also complicates the preparation of seasonal forecasts from snow survey data.

In spite of the great contribution that snow surveys have made to this problem, there is room for much improvement. The snow over wider areas in the remote and inaccessible mountain ranges must be more adequately sampled. Sampling frequency must be greatly increased. Records of the amount of fall rain which may precede the snow season are essential to a proper analysis of spring conditions on the watershed. Has the soil and other natural moisture reservoirs been primed by fall rains or will some portion of the spring snow-melt water be retained for this purpose? Is water lost from melting snow by evaporation? Are such losses greater during a delayed season when a deep high mountain snowpack is carried over into the late, hot spring months? Is there an appreciable contribution to the water equivalent content of a snowpack from condensation? If so, does condensation have a greater influence on runoff from a snow pack carried over into the late spring than on a pack which melts early in the season? These are just a few of the questions which must be answered before improvements may be made in the forecasts of seasonal water supplies from mountain snow fields.

The Weather Bureau, whose function it is to forecast the flow of streams, uses accumulated winter precipitation, as reported from more than 350 key stations selected from its extensive network of precipitation stations, as an index to accumulated snowfall. Using only regular monthly reports, this technique is far less costly than snow surveys. The

The Central Sierra Snow Laboratory, which is located at an elevation of 6,900 feet, near Donner Summit, California. In this picture, taken in January, 1946, the snow is more than 12 feet deep.

method permits preparation of forecasts as early as January 1st, giving water users ample time to plan for the coming spring and summer operation. Forecasts for over 250 points in the western states are prepared by Weather Bureau forecast offices at Salt Lake City, Utah; Portland, Ore.; Kansas City, Mo.; and Sacramento, Calif.; and bulletins are issued each month from January through May.

Although seasonal forecasts serve their purpose in a limited way, a day-by-day forecast of water supplies from the melting snow is required for satisfactory operation of the multi-billion-dollar dams and irrigation distribution systems in California. The water master responsible for the operation of the multi-purpose dams, such as Shasta, and the many others proposed or now under construction in the Central Valley project, must regulate reservoir outflow to provide the legal flood control reserve in the reservoir. A definite supply of water for hydroelectric power must be released and, at the same time, the maximum amount of water must be conserved for summer irrigation. Unless a reasonably precise short-term forecast of meltwater flow from the high mountain watersheds can be provided, there may be a serious waste of precious water supplies.

(Continued on page 132)

Types of Solid Precipitation in Snowstorms

VINCENT J. SCHAEFER, GENERAL ELECTRIC RESEARCH LABORATORY

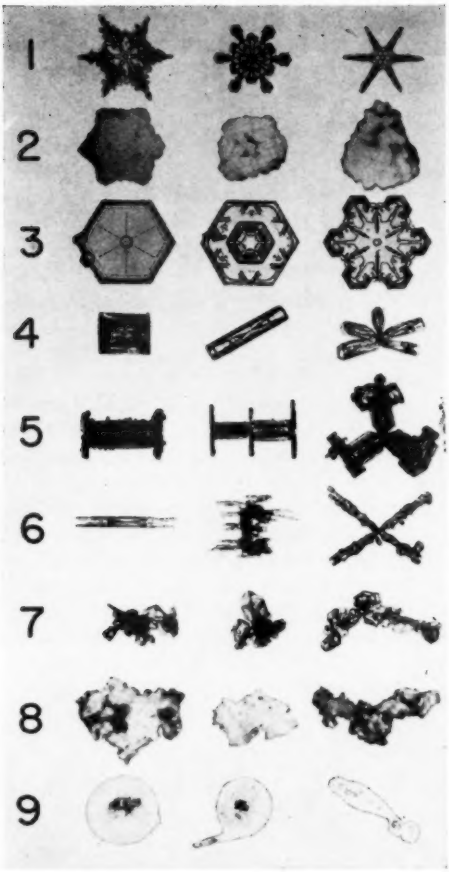
THERE ARE FEW THINGS in our physical world of more importance to life than the substance we call water. It occurs as a gaseous vapor, as well as in liquid and solid form. Although not a very complex molecule, there are certainly many properties concerning this combination of oxygen and hydrogen atoms which we do not understand.

One of the most fascinating forms of water is the crystalline mineral — ice. Whether it is part of a tremendous glacier or a floating bit of "diamond dust" — the tiniest of the snow crystals — a better understanding of the factors which lead to its formation is one of intriguing scientific interest. A better knowledge and appreciation of some of the features of snow crystals and other forms of solid precipitation will undoubtedly add to the fun of observing and studying the weather.

In the past, various proposals have been made for the establishment of a classification method to assist in making scientific observations. To be usable, such a system must be simple and yet sufficiently inclusive to be used wherever such precipitation occurs. Before any classification system is finally accepted as an international standard, a survey must be conducted in all parts of the world to determine the basic forms.

The types shown in the picture opposite were selected by the writer after considering the suggestions of Bentley, Nakaya, Klein, Weickmann, Dobrowolski, and others, and profiting from personal field observations made over a number of years. What is perhaps even more important is that the chart has been used successfully in the field by a group of co-operative amateur snowstorm observers during the winter of 1945-1946; and it was used by members of the recent Finn Ronne Antarctic expedition, who reported that no precipitation forms were observed in

Code	*Type*	*General Form*	*Occurrence*	*Size Range*
1	Stellar Crystals	Six-rayed, starlike, showing a wide variation in detail, often of very delicate dendritic structures.	Single crystals clumped flakes	1/32″ - 1/2″ 0.1 - 1.3 cm.
2	Graupel	Pellets or grains, generally rounded, with crystalline form altered by heavy coating of frozen cloud particles.	Rarely clumped	1/32″ - 3/8″ 0.1 - 1.0 cm.
3	Hexagonal Plates	Thin, solid or semisolid hexagonal, icy platelets often containing air inclusions. Smallest crystals are called diamond dust.	Rarely clumped	1/1000″ - 3/16″ 0.0025 - 0.5 cm.
4	Hexagonal Columns	Transparent, generally flat-ended, sometimes pointed prisms often with air inclusions. These produce 22° and 46° halos around sun or moon.	Rarely clumped	1/64″ - 1/8″ 0.05 - 0.3 cm.
5	Capped Hexagonal Columns	Icy, hexagonal columns terminated by expanded hexagonal plates or other queer structures.	Rarely clumped	1/64″ - 3/16″ 0.05 - 0.5 cm.
6	Ice Needles	Slender columns often terminated by sharp points around periphery.	Often clumped	1/64″ - 3/8″ 0.05 - 1.0 cm.
7	Asymmetrical Crystals	Angular crystals lacking in symmetry and often showing dendritic growths in random directions.	Often clumped	1/64″ - 1/8″ 0.05 - 0.3 cm.
8	Powder Snow	Dry bits of snow without symmetry or angular crystalline faces.	Sometimes clumped	1/64″ - 1/8″ 0.05 - 0.3 cm.
9	Sleet	Pellets of translucent or transparent ice often having bumps or a pointed growth. Consist of frozen rain drops.	Very rarely clumped	1/32″ - 1/4″ 0.1 - 0.6 cm.
10	Hail	Rounded, pyramidal, or irregular-shaped ice particles.	Very rarely clumped	1/8″ - 1″ 0.3 - 2.5 cm.



Types of frozen precipitation showing the various forms that are found under the first nine classifications given in the table on the facing page.

that region which could not be described by using this system. The present chart is a revised form of one originally used during 1943-1944 at Mt. Washington Observatory.

At the meeting of the International Commission for Snow and Ice held at Oslo in August, a committee was formed to attempt the establishment of an international terminology and classification system of snow and ice forms. The Amateur Weathermen of America can be of real assistance in this task by reporting precipitation forms not adequately covered by the chart. The writer, who is a member of this committee, will welcome comments and suggestions in relation to this interesting problem.

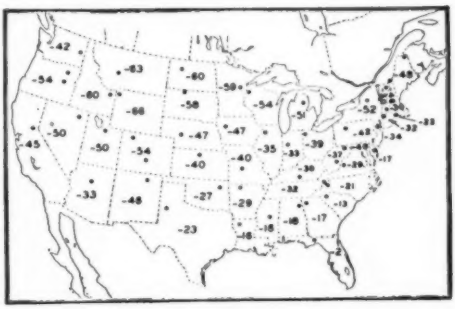
RECORD LOW TEMPERATURES

EVERY STATE in the Union has experienced below zero temperatures. The great cold wave of 1899 carried the zero line to the Gulf coast of Alabama and even into Florida (Mobile −1 and Tallahassee −2). There are, however, many areas in those states and also along the Atlantic, Gulf, and Pacific coasts that have never even closely approached the mystic mark of zero.

As we look back over the records of the past 70 years, the invasion of arctic air in February, 1899, stands out above all others. Despite the relatively small number of reporting stations then in existence and the 50-year span that has elapsed, the lows then set are unsurpassed on the books for nine states all the way from the Canadian border to the Gulf of Mexico. On February 10, 1899, the low marks for Ohio (−39) and for Virginia (−29) were established. The next day a second impulse of frigid air sent the mercury tumbling all the way down to −63 in Montana. As the air mass pushed southeastward, records were set in Nebraska (−47) and in Texas (−23). On the 13th and final day of record-making the deep South experienced its lowest readings: Kentucky −30, Florida −2, Mississippi −16, and Louisiana −16.

Another memorable cold wave occurred in 1905, also in the second week of February, when the cold air headed directly south from the Montana border. Marks were set in the south-central areas: Alabama −18, Arkansas −29, Kansas −40, Missouri −40, and Oklahoma −27.

The coldest air mass of all, but of limited penetration, entered the northern Rocky Mountain region in the second week of February, 1933. At −66°, the thermometer of the Riverside Ranger Station at West Yellowstone, Wyoming, exceeded by three degrees the lowest ever registered in the United States. In nearby states the following records were set: Oregon −54, Colorado −54, Utah −50 (equaled), and Texas −23 (equaled).



On this chart, showing the lowest temperatures experienced in the United States, the dots mark the location in each state where the lowest temperature was recorded.

Midwinter Temperature Antics in the Black Hills*

D. C. CAMERON

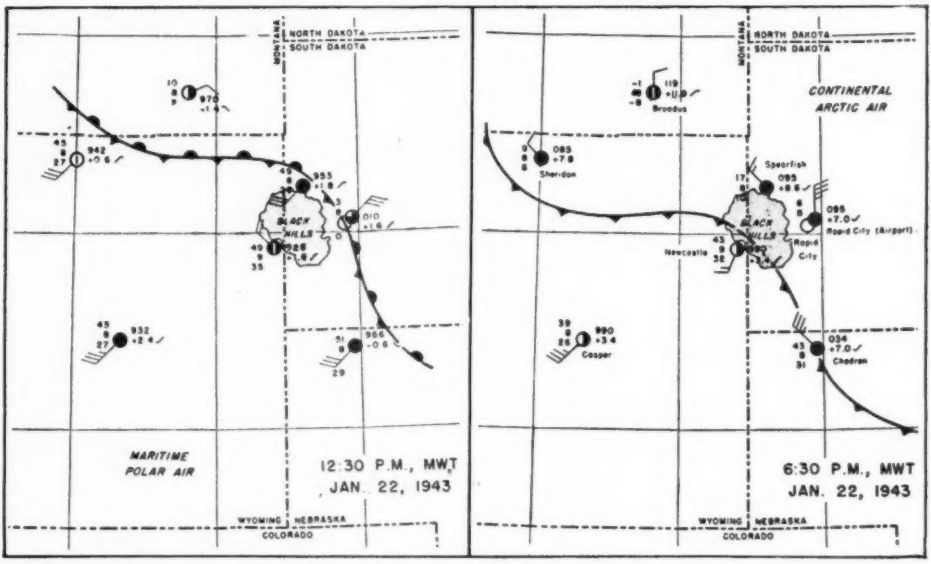
THE BLACK HILLS REGION of western South Dakota is famous for its pronounced chinook winds which not infrequently convert midwinter into balmy spring. At no other place along the eastern foothills of the Rocky Mountains does the phenomenon of adiabatically heated air (air warmed due to compression as it flows downslope) reach such proportions. The area has been the scene of many very abrupt manifestations of this process when the cold of the arctic has been magically displaced by mild breezes from above and beyond the Rockies. And it also has had some bitter reverse experiences when the chinook has been violently displaced by stinging cold.

Here are some examples of previous large-scale temperature fluctuations at Rapid City (elevation 3,200 feet) at the eastern edge of the Black Hills. On January 13, 1913, the temperature rose 64° in 14 hours, from −17° at 8:00 a.m. to 47° at 10:00 p.m. At 8 p.m. on December 28, 1933, the mercury was down to zero, but at 1:45 the next afternoon it stood at a mellow 67°. For a downward plunge, consider the 47°-drop in 15 minutes from 7:00 to 7:15 a.m., on January 10, 1911.

None of these displays of nature, however, equals the violent antics of the temperature that took place in mid-January, 1943. Not only did the thermometer flip-flop up and down as much as 40° to 60° in a few minutes, but several places experienced this process as many as five or six times in a single day.

The first act of this January drama commenced on the 20th when higher communities in the Black Hills, such as Lead (elevation 5,119 feet), experienced a chinook of such phenomenal suddenness that plate-glass windows were cracked due to the thermal action. Mild chinook conditions continued for the next couple of days. At Deadwood, adja-

*Condensed from the **Monthly Weather Review**, March, 1943, pages 29-32.



The relative positions of the air masses concerned in the temperature fluctuations in the Black Hills region on January 22, 1943. As the map on the left shows, in the middle of the day the warm air on or near the surface extended as far north and east as Spearfish and Rapid City, but by evening the cold air was pushing well southward, as shown by the chart on the right. Adapted from the *Monthly Weather Review*.

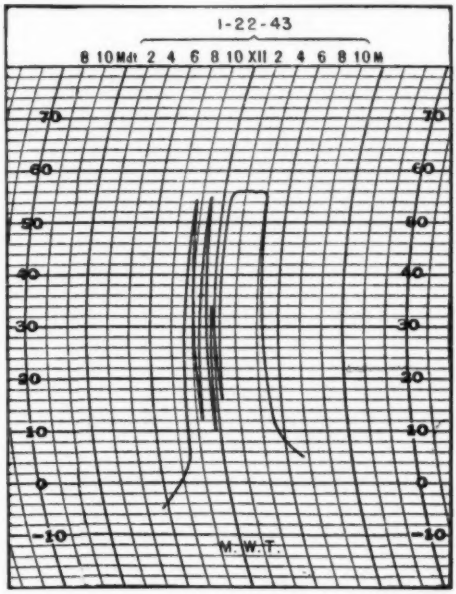
cent to Lead but in a canyon 600 feet lower, the warming did not take place until evening of that same day: a temperature difference of over 50° existed between the two cities all afternoon. At one time it was 52° in Lead and −16° in Deadwood, a distance of 1½ miles!

Upper air soundings during this period revealed that even as far away as Bismarck, N. D., some 200 miles to the northeast, a pronounced temperature inversion (warm air immediately above cold) existed at from 3,400 to 4,600 feet above sea level. Where this temperature inversion came in contact with the ground in the Black Hills region these violent temperature fluctuations occurred. The warm air was flowing northeastward at gale speed, riding up over the denser arctic air, which in turn was pressing southwestward up the slopes of the mountains and hills. Turbulence in the warm air in the lee of the hills caused it to surge downward in great bursts, only to be almost immediately displaced by the sea of subzero cold air.

The battle of the air masses culminated on the 22nd of January when the warm air made its farthest penetration down the east slopes and extended briefly during the afternoon out onto the plains, where the Rapid City Airport recorded a maximum temperature of 50° F. Earlier that morning it reached Spearfish at 7:32, with a rise of 49° in two minutes (−4° to 45°). At 9:00 a.m., the mercury plunged from 54° to −4° within 27 minutes. The phenomenon progressed southward and was felt at Rapid City about 9:30, where the following downtown temperature record, also shown in the graph, indicated the violence of the fluctuations.

Hour	*Temp. F.*	*Remarks*
0530	−5°	— — — —
0920	5	10° rise in 4 hours
0940	54	49° rise in 20 minutes
1030	11	43° fall in 50 minutes
1045	55	44° rise in 15 minutes
1130	10	45° fall in 45 minutes
1150	34	24° rise in 20 minutes
1215	16	18° fall in 25 minutes
1240	56	40° rise in 25 minutes
1600	56	Balmy and mild for over 3 hours
1700	12	44° steady fall for one hour
1730	5	Back to the early morning level

The frontal picture shown in the map may be misleading. There was not a vertical front or wall of cold air, but rather a horizontal "shore line" of a great sea of cold air which was lapping the "coast line" of the Rockies. Probably only a hundred feet or so off the ground at Rapid City Airport at 12:30 p.m., mild conditions approximating those at Spearfish prevailed. The greatest fall in



The thermograph trace of the January 22nd variations at Rapid City. Compare this record, made of temperatures in the downtown section of the city, with the accompanying table.

temperature accompanying the movement of these contrasting air masses was 75° at Box Butte, Nebraska, to the south.

This battle continued for two days. Motorists reported remarkable experiences. Slight changes in altitude as one drove along brought almost instantaneous temperature rises and falls of over 50°. In passing from the cold into the warm air, the outside of a car would instantly frost over as the moisture in the warm air condensed on the extremely cold metal and glass surfaces. Visibility for the driver was instantly reduced to zero. The following account by C. A. Barnes, chief airway communicator, Black Hills Airport, Spearfish, S. D., tells a dramatic story.

I live in St. Onge, about five miles north and three miles east of the station. When I left home the

(Continued on page 138)

POLAR WEATHER FLIGHTS

B. C. HAYNES, U. S. WEATHER BUREAU

THE NORTH POLE has been the goal of conquest and exploration ever since Willem Barents made the northward thrust to latitude 77° 20′ north at longitude 52° east in 1594. During the 17th, 18th, and 19th centuries many attempts were made to reach the pole, but all were unsuccessful. Robert E. Peary first succeeded in reaching the latitude of 90° north on April 6, 1909. Vilhjalmur Stefansson, a great modern polar explorer, says there are two reasons why men search for the pole: first, to discover short sailing routes across the Arctic Ocean and, second, because of the glamour of reaching a unique point in the Arctic. In his book, *The Friendly Arctic*, he states, "The world in general has imagined the North Pole to be

The North Pole, showing the ice pack over the polar sea. Photograph taken from 18,000 feet on August 2, 1948, by the author.

to the Arctic what the mountain top is to the mountain."

Meteorologists have now added a third reason for desiring to reach this special point where all longitude lines converge, and where there is only one cardinal direction, "south." Meteorology is still in the era of exploration. In studies of the nature of world-wide atmospheric circulation, there have always been great blank spaces in the weather maps over the arctic and antarctic regions. Because of the long periods of continuous sunshine and darkness at the poles, these regions have special properties with respect to incoming and outgoing radiation. A study of the heat balance in the atmosphere shows that certain areas emit more radiation to space than is received from the sun. In other regions of the earth the opposite is true. A balance is created by the transport of heat through atmospheric movements, or wind. Many theories on the general circulation have been based on incomplete data from the polar regions, and, in order to obtain a more complete analysis and understanding of the interchange of air between the equator and the poles, further meteorological explorations and observations are required in the arctic and antarctic areas.

In March, 1947, the Air Weather Service, meteorological agency for the U. S. Air Force, established weather reconnaissance flights to the North Pole. The flight route called "Ptarmigan," as tracked by the 375th Reconnaissance Squadron VLR (Weather) on a schedule of at least one every other day, originates at Fairbanks, extends northeastward to Aklavik, Canada, thence to Prince Patrick Island, northward along longitude 123° west to the North Pole, and finally southward along the 159th west meridian to Pt. Barrow, Alaska, and to Fairbanks. Since inauguration of the Ptarmigan flights, over 100 successful missions have been flown to the pole, with more than 350 persons participating.

On August 2, 1948, I had the good fortune of being one of those persons. As chief of the Weather Bureau's Meteorological Observations Section, I was particularly interested in the detailed methods used by the Air Weather Service in weather reconnaissance. Also, as a member of the polar commission of the International Meteorological Organization, I was interested in arctic and polar meteorological problems and in the state of the ice pack over the Arctic Ocean.

The operational procedures followed by the weather reconnaissance groups are excellent and provide for every emergency. The

Air Weather Service RB-29 aircraft on weather reconnaissance over Alaska. Planes of this type regularly fly the Ptarmigan route. Air Force photograph.

day before our flight a thorough and complete briefing was held by the squadron commander with the personnel who were to make the flight. Details of navigation, meteorology, radio, and emergency procedures were discussed, and survival clothing and equipment were checked by each member of the crew. I was completely outfitted and, following the briefing session, our equipment was placed aboard the aircraft, a B-29 modified to function as a flying weather-observing station. I was instructed on "bail-out" and "ditching" signals and assigned a crash position and "bail-out hatch."

With all this preparation for an emergency, one might think that the crew had great fear of impending disaster. On the contrary, the pilots and airmen who fly the Ptarmigan route have a feeling of security greater perhaps than those who fly the reconnaissance routes over open water. They place a great deal of dependence on the ice field as a place to negotiate a reasonably safe landing and to establish a fairly comfortable emergency camp.

On August 2nd, a bright morning greeted me even though my alarm got me out of bed at 2 a.m. (Alaska standard time). By 2:30, the sun was shining on the snow-covered Alaska Range some 100 miles away, and I was on my way by jeep through the cool, crisp air to breakfast with the crew. Afterwards, I accompanied the pilot, navigator, and weather officer to the base operations office, where final clearance papers were prepared for the flight. In the meantime, the copilot and crew chief were supervising the pre-flight inspection of the aircraft.

At 4:15 a.m., 14 of us boarded the B-29. Twenty minutes later, our pilot, Lt. David Laughman, headed our plane down the runway and we were quickly air-borne despite

"North" polar bands of cirrus clouds taken at 89° 30′ north latitude, 137° west longitude, altitude 18,000 feet. Photograph by B. C. Haynes.

our heavy load of gasoline. A gradual climb in a northeasterly direction was made to 18,000 feet. There were only a few clouds, but owing to the low angle of the sun's rays the mountain valleys were still in shadow. We crossed the great Yukon River, passed over the little settlement of Aklavik, Canada, where the Canadian Meteorological Service maintains a rasonde station, and thence over the Beaufort Sea. The clear blue water of this part of the Arctic Ocean soon became spotted by ice floes, which at latitude 72° north joined to form the continuous ice pack.

We flew on the 500-millibar pressure surface and determined its height along our flight track by means of a radio altimeter. Each half hour a complete weather observation was taken and recorded by our weather officer, Lt. L. L. Howes, and radioed back to a land station. Ptarmigan weather reports have proven to be highly accurate and of great value to meteorologists stationed throughout North America. Wind determinations were made by the navigators, using visual drift, celestial locations, radio, or radar methods. Temperature, humidity, height of the 500-millibar pressure surface, clouds, and weather were observed by the weather officer.

Before the flight, I had set up desired specifications for the weather which would enable me to observe ice conditions in critical areas. First, I wanted clear weather between the continent and the edge of the ice pack — this I had — and, second, I hoped that there would be no clouds below our flight level at the North Pole. What happened in between did not matter so long as there was something of meteorological interest to observe.

As we continued northeastward, a lower cloud layer began to obscure the ice, and this cloud deck was continuous to Prince Patrick Island, which was also obscured. Clouds continued northward from there, and at about 80° north I really began to worry about not being able to see the polar ice pack. Occasionally, however, the ice pack was visible through holes in the lower clouds.

We were flying between a broken layer of cirrus clouds at 25,000 to 30,000 feet and a lower altostratus deck, the top of which was estimated at 12,000 feet. At 83° north, we could look ahead some 50 miles and see the edge of the lower clouds and the ice pack that stretched beyond to the horizon. We passed the edge of the low clouds, and came out over a wide expanse of broken ice. The visibility was excellent, and as we approached the pole, I suddenly realized that I was looking northward across the pole southward. At 12:30 p.m. Alaska standard time, the navigators, who had been very busy taking sun lines and drift readings, announced that at 12:50 p.m. we would be over the pole.

Final celestial checks were made at 12:50 p.m., and we began a slow circle to the left over the North Pole. At that moment my thoughts were of Peary, Byrd, and Amundsen, and of the difficulties and hardships suffered on their expeditions to this lonely "co-ordinate" of the earth, and of what their thoughts might have been. With modern pressurized and heated aircraft, automatic pilot equipment, and three specially trained navigators using modern grid-system polar navigation methods, achieving the pole itself has very little meaning. It is merely point X, or the turn-around point for another weather reconnaissance flight. Yet there was a certain thrill in knowing I was there. Everywhere I looked was south. My watch, set to Alaskan time, could not indicate a polar noon or midnight in the normal way, since at the pole there is no single meridian, and there are six months of light and six months of darkness. It is indeed a unique point in our usual standards of time and directions.

The ice over the polar sea was broken and looked something like the ice pack I had seen in the Ross Sea on my trip to the Antarctic with the Navy's operation *Highjump* in January and February, 1947. The major differ-

ence was the lack of huge icebergs in the north polar region. The North Pole is over a deep ocean where the sea ice is flat but may become tilted when broken and pushed into pressure ridges by strong winds. There are no direct sources for large bergs, however, on the Arctic Coast of North America.

About 50 miles south of the pole on our homeward flight in the direction of Point Barrow, Alaska, low cloud layers again obscured the ice. From this point southward we experienced about every type of weather that could be expected at our flight altitude. The 500-millibar surface on which we were flying lies at about 18,000 feet above sea level. We were not in the stratosphere, however, as its base was about 10,000 feet above us. The cirrus clouds we observed above us were near the base of the stratosphere.

We passed through a series of cloud bands, each about 50 miles wide and extending in an east-west direction as far as we could see. The temperature at flight level was 4° F. below zero, and each cloud we passed through deposited ice on the aircraft. This indicated that the clouds were composed of water droplets which had been cooled far below the normal freezing point for water.

As we approached the coast of Alaska, we encountered continuous clouds, and after taking the last scheduled reconnaissance observation, the pilot climbed to 19,500 feet to try to avoid further icing. This continued, however, and chunks of ice flung from the propeller blades sounded like brickbats striking the fuselage. We then decided that a descent to lower levels would bring us into above-freezing temperatures. At 13,000 feet, the ice, which was about ½-inch thick on parts not protected by de-icers, began to melt off. A smooth descent and perfect landing were made by our pilot at Ladd Air Force Base, Fairbanks. We taxied to the parking area at 9:10 p.m. We had been aloft 16 hours 35 minutes, and a tired but alert weather reconnaissance crew was glad to have chalked up another perfect Ptarmigan.

IT'S HARD TO BELIEVE

More snow has been recorded in one day in Galveston, Texas (15.4 inches in February, 1895), than in Chicago (14.9 inches in January, 1939).

Weather Instruments
for your
Christmas Gift List

THERMOMETERS

Official Weather Bureau type	$ 3.95
Large window type, red reading	3.50
Indoor-outdoor, 5′ capillary tube	7.50
Maximum-minimum, magnet type	10.00
Maximum-minimum, Weather Bureau	22.50

HYGROMETERS

Fixed wet and dry bulb, Mason type	$ 7.50
Sling psychrometer, Weather Bureau	8.80
Hair element, direct reading	17.50

BAROMETERS

Baroguide with forecast dial	$ 9.00
Weather Barometer, graduations to .02″	18.00
Meteorological Barometer, Weather Bureau	30.00
Deluxe Barograph, seven day period	144.00

RAIN GAGES

Green type, 3″ dia. — 10″ cap.	$ 7.95
Weather Bureau, 8″ dia. — 20″ cap.	22.50

WIND INSTRUMENTS

Wind vane, N E S W letters	$ 5.50
Anemometer, electric, direct reading	48.50
Wind vane with flashing light indicator	39.00
WINDIAL, speed and direction indicators	225.00

BOOKS

Haynes, Techniques of Observing	$ 4.00
Starr, Basic Principles of Forecasting	3.00
Kohn, Meteorology for All	2.00
Yates, Weather for a Hobby	2.75

COMPLETE WEATHER STATION FOR AMATEURS — KIT NO. 1

Maximum-minimum thermometer, hygrometer, shelter, rain gage, baroguide, wind vane, instruction book, and record forms $49.75

Send your check or money order. All prices f. o. b. Philadelphia. Shipment by railway express collect, or we will bill you for postage charges.

Science Associates

"Everything for the study and practice of meteorology"

Write for free catalog

401 North Broad Street, Philadelphia 8, Pa.

(Continued from page 123)

Improvements in Forecasting Snow-melt and Stream Flow

In order to improve our knowledge of the factors which influence snow-melt and to develop procedures for obtaining a more satisfactory inventory of the snow in high mountain areas, three intensively instrumented snow research laboratories have been built in the West. These laboratories are operated as the Cooperative Snow Investigations under a joint agreement by the Corps of Engineers and the U. S. Weather Bureau.

The Central Sierra Laboratory, located near Donner Summit, California, consists of a well-instrumented, four-square-mile basin, ranging from 6,900 to 9,100 feet in elevation. The Willamette Basin Snow Laboratory, an 11-square-mile area in the middle Cascade Range, is located on the Blue River, a tributary of the McKenzie which joins the Willamette near Eugene, Oregon. The Upper Columbia Laboratory, located near Marias Pass, Montana, on the west slope of the Continental Divide, includes a 21-square-mile basin at the headwaters of the Flathead River.

These snow research laboratories consist of a main headquarters building with living quarters for the personnel and, at the Central Sierra and Upper Columbia Laboratories, facilities for highly specialized physical and meteorological research.

Continuous microclimatic data are collected and automatically recorded on strip-chart recorders. In addition, continuous records are made of total incident radiation and radiation reflected from the snow. Snow and soil temperatures and soil moisture data are obtained either on continuous recorders or at frequent intervals with manually operated instruments. Numerous observation stations are distributed throughout each laboratory basin. Runoff from the experimental basins is measured at one or more stream-gaging stations.

Data from these laboratories all flow to a processing and analysis unit composed of Weather Bureau and Corps of Engineer personnel. This unit, which is located in the South Pacific Division Engineer office in Oakland, has access to all synoptic meteorological, raob, pibal, and rawinsonde data normally collected by the Weather Bureau.

Two types of seasonal snow storage gages used in the western mountain snowfall areas. *Left:* Gages of the conical type (Sacramento storage precipitation gage) are constructed with capacities of 60, 100, 200, and 300 inches. *Right:* The "standpipe" gage is capable of holding the entire seasonal precipitation.

Both types are charged with a 33-per-cent calcium chloride solution in the late summer. This solution converts the snow into liquid and prevents the precipitation from freezing. The seasonal precipitation is weighed out in the late spring and the record used in preparation of seasonal water supply forecasts. Interim measurements may be made with a graduated stick and reference table, or with a chalked line.

The four broad objectives of this co-operative snow investigation are:

1. To determine a practicable and reliable method of evaluating maximum stream flow which may be produced by snow-melt or by combined rain- and snow-melt.

2. To develop a practicable and reliable method of forecasting seasonal and short-term stream flow, including floods, resulting from snow-melt or combined snow-melt and rain.

3. To expand our basic knowledge of the hydrodynamic and thermodynamic characteristics of snow through a program of fundamental scientific research.

4. To increase our knowledge of meteoro-

logical and hydrologic phenomena as they influence the above three objectives.

These four broad objectives have been broken down into about 50 specific problems. The processing and analysis unit of the Cooperative Snow Investigations, as its name implies, endeavors to apply the data collected from the laboratories to the solution of these specific problems.

The results of these snow investigations should go a long way toward solving some of the difficult problems associated with the design, construction, and operation of the five-billion-dollar water resources development program in the western states. In the Central Valley alone, a satisfactory solution to the forecasting of water supplies can add a quarter of a billion dollars to the agricultural income of the farmers and ranchers of California.

News Notes

PETTERSSEN AT WASHINGTON

The noted Norwegian meteorologist, Dr. Sverre Petterssen, has recently accepted the position of director of the new office of Scientific Services at headquarters, Air Weather Service, Washington, D. C. The author of several meteorological books and many scientific papers, Dr. Petterssen has earned world-wide recognition in meteorology. He has resigned as deputy director of the Norwegian Weather Bureau, and plans to become a citizen of the United States.

As head of the new office, Dr. Petterssen will survey and appraise all new developments in meteorology, determine the requirements for research and development of new equipment and methods necessary to improve weather service and to provide world-wide climatological data.

Dr. Sverre Petterssen is welcomed to headquarters, Air Weather Service, Washington, D. C., by its commander, Brigadier General Donald N. Yates. U. S. Air Force photo.

Dr. Petterssen first visited the United States in 1935 to deliver a series of lectures at the invitation of the U. S. Navy. In 1939, he became chief of the meteorology department of Massachusetts Institute of Technology. During World War II, recalled to active duty with the Norwegian Air Force, he worked with British meteorologists on analysis of upper air circulation; later he assisted in forecasting for landings south of Rome and in Normandy. Since the close of the war he has held key positions with the International Meteorological Organization.

FEDERAL METEOROLOGIST EXAMINATION

A meteorologist examination has been announced by the U. S. Civil Service Commission for filling positions in various federal agencies in Washington, D. C., and vicinity. Positions in the U. S. Weather Bureau throughout the country and a few elsewhere may also be filled. The salaries range from $3,727 to $6,235 a year.

A written test will not be required, but applicants must have had four years of technical or scientific experience in meteorology or related fields or have completed a full curriculum of college study leading to a bachelor's degree with 20 hours of laboratory work in meteorology. Other combinations of experience and education may be acceptable, but, in addition, all competitors must have had from one to four years of professional experience in meteorology.

Further information and application forms may be obtained from most first- and second-class post offices, from Civil Service regional offices, or from the U. S. Civil Service Commission, Washington 25, D. C., where applications will be accepted until June 30, 1949.

Amateur Weathermen of America

For information on membership in the Amateur Weathermen of America, write to David M. Ludlum, Director, AWA, Franklin Institute, Philadelphia 3, Pa.

THERE has always been plenty of weather whirling across the inland counties of Northern Michigan, but until recently no one kept full tabs on its varied behavior. Now, however, an energetic amateur weatherman at Iron Mountain boasts a complete private weather station with equipment equal to most first-class Weather Bureau installations.

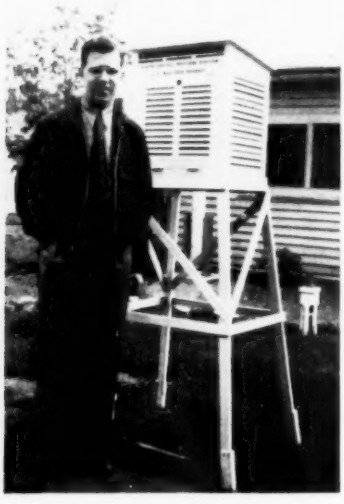
About five years ago Gene Patrick became interested in aeronautics and took a course at the Iron Mountain High School. Of all the phases of aviation, the subject of meteorology caught his fancy, so he determined to establish his own observatory and weather service.

As is usual with weather amateurs, a barometer was the first instrument obtained, then followed a hygrometer, small shelter, rain gage, and psychrometer. Today, over 47 pieces of equipment are employed in taking the three daily observations at 8:00 a.m., 2:00 p.m., and 8:00 p.m. This daily routine was started on July 11, 1943, and to date over 6,000 observations of the elements have been put on the books. From merely taking observations, Patrick branched out into forecasting and supplying a climatological service. His activities have ranged all the way from calculating the total tonnage of water falling on Iron Mountain during a rainstorm to measuring the gallons of water evaporating from nearby lakes in the summertime.

The installation, known as the North Central Weather Station, is located at 605 West B Street, about seven blocks west of the business district of Iron Mountain (longitude about 88° west, latitude 45°.8 north) in the home of the 23-year-old weatherman. The office contains a desk, filing cabinets, mercurial barometer in glass case, barograph, aneroids, and indoor wind indicator. A varied assortment of meteorological charts and maps adorns the walls, and an up-to-date library contains standard reference works as well as current periodicals.

In the rear of his home, Mr. Patrick has set up the following instruments: large instrument shelter, psychrometer, maximum and minimum thermometers, rain and snow gage with support, electric anemometer and wind vane, evaporimeter, and soil thermometers. The wind support pole is 35 feet high and so rigged that it can be easily lowered to the ground for inspection and servicing.

Each month a summary of observations similar in form to USWB No. 1030 is issued. In addition to strictly meteorological sum-



Left: Gene Patrick and the large instrument shelter in the rear of his home, where he conducts his observations.

Above: The office of Mr. Patrick's weather station, showing several kinds of instruments, with conveniently organized space for working and for wall charts.

maries, it contains complete psychrometric data of great value to air-conditioning and heating engineers of the Iron Mountain district. Copies of this summary are distributed to interested parties.

Mr. Patrick estimates that his private investment in equipment and supplies for the North Central Weather Station has run well over one thousand dollars — all out of his own pocket. And now he has just one more desire, that is to add a recording rain gage to his array to round out his set of recording instruments.

This year he established a substation at a private airport owned by Joseph Van Hulla, 4.5 miles southeast of Iron Mountain. Here temperature, precipitation, and wind records are maintained and current weather advice is always available to assist local pilots, who otherwise would be without a weather service.

This remote section of Northern Michigan derives many benefits from the individual efforts of Mr. Patrick. He supplies fuel oil dealers with temperature records and local degree-day data; his forecasts assist the highway department in meeting rough weather conditions; his advice not only helps individuals, but also aids officials in planning public events. His precipitation records are used constantly by forestry and conservation engineers. The community of Iron Mountain is fortunate in having a citizen with such initiative and energy as displayed by this amateur weatherman.

WEATHER CORRESPONDENCE COURSE

The Pennsylvania State College is offering a correspondence course on the subject, "Weather and Man," based on a textbook of the same title written by Hans H. Neuberger and F. B. Stephens (Prentice-Hall, 1948). The course comprises a nontechnical treatment of the fundamentals of meteorology and an evaluation of weather and climate as related to man's economic and social activities. It contains 15 lesson assignments and one final examination and carries two college credits. Further information concerning this and other nontechnical and technical courses in meteorology may be obtained by writing to Mineral Industries Extension Services, at the Pennsylvania State College, State College, Pa.

MAKE AN ASTRONOMICAL REFLECTING TELESCOPE FOR AS LITTLE AS $6.00

SAME PRINCIPLE AS THE 200-INCH TELESCOPE ON PALOMAR MOUNTAIN

Now you too can afford the luxury of a REAL telescope. See the mountains of the moon, Saturn's rings, Jupiter's moons, nebulae, clusters, the companion of Polaris, and other heavenly wonders. Now for $6.00 you can make a 3-inch Newtonian reflecting telescope. We sell you the completely finished optical units. Other parts are usually found in any home or purchasable for a few cents.

We furnish a 3-inch reflecting mirror (39" F.L.) accurately ground, polished and hard aluminized, a "flat" mirror and 3 eyepiece lenses (40 and 50 power). You are assured hard sharp images without fuzziness or rainbow effects.

The high precision quality of the optical parts is guaranteed by our international reputation for fine scientific apparatus.

Thousands of amateurs have built these scopes. So can you!

Send $6.00 and receive the parts described with full simple directions and a reprint of an article from a recent issue of a well known scientific magazine telling how this telescope is built in four hours. Reprint alone 10c.

This instrument is also ideal as a spotting scope and for bird study.

3" Reflector	39" F.L.	$ 6.00
4" "	56" F.L.	10.00
5" "	67" F.L.	15.00

AVAILABLE ACCESSORIES

(1) **EYEPIECE:** Achromatic triplet, flat field, sharp to edge, 1" E. F. L., completely mounted, ready for use. 1¼" O.D. $7.50
(2) **EYEPIECE HOLDER:** with built-in diagonal support, 1¼" I.D. Brass throughout 3.50
(2a) Extension tube for above 1¼" I. D. .. 1.50
(2b) Glass diagonal for above with aluminized front surface ..... .50
(3) **PRISMS** (Unsilvered) 1" x 1" face 3.00
(4) **DIAGONAL,** 4-arm, using above 1" x 1" prisms 10.00

COMBINATION PRICE — SAVE $3.50

a) 5" Reflector
b) 1" E. F. L. Eyepiece
c) Eyepiece Holding and Focusing Device
d) Diagonal Mirror

$23.00 Postpaid

PRISM BINOCULARS

All Taxes Paid

The finest glasses obtainable today. Sharp, clear, brilliant images. Ideal for all year around day and night use. Satin black finish in leather case with safety straps.

8 power, 25 mm. objective $32.94
8 power, 30 mm. objective $78.00
8 power, 32 mm. objective $51.24
Field Glass, 4 power, 40 mm. objective ... $17.69

BALLOON BALANCES

CEILING OR PILOT TYPE

40 grams, 120 grams, 140 grams. Metal or plastic. Used naval surplus ..... $2.50 to $5.00

Include Postage - Remit with Order

Send 50c for Up-to-the-minute Catalog

HARRY ROSS

TELESCOPES - MICROSCOPES
Scientific and Laboratory Apparatus

74 West Broadway, *Section A*, New York 7, N. Y.

WORKSHOP FOR WEATHERMEN

CONDUCTED BY CHARLES A. LAIRD

How to Construct a Mercurial Barometer

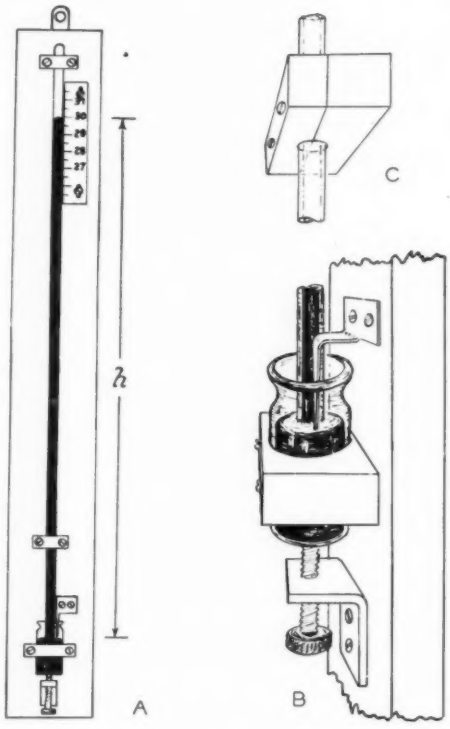
THE BAROMETER, sometimes called the "footrule of the air," is the weatherman's most useful tool. A mercurial barometer comprises a mercury-filled glass tube about 35" long, inverted in a container of mercury. Air pressure on the surface of the mercury in the container keeps the mercury in the tube, and variations of this pressure change the height of the liquid column. To read the barometer means to measure the distance from the surface of the liquid in the container to the top of the mercury in the column.

The barometer described here is easy to build and has all the essentials of expensive factory-built instruments. While it may not be quite as accurate, its indications meet the requirements of the amateur weatherman very satisfactorily. Possibly the greatest difficulty will be in procuring the mercury, of which more than a pound is required, and in paying the high price it has at the present time. It should be clean and pure.

For the mounting support, use ¾" seasoned pine board or plywood, 40½" long and 5" wide. As shown in part A of the diagram, a piece of sheet metal fastened to the back of the board will serve as a hanger. A glass tube, ¼" inside diameter and 35" long, serves as the mercury container. Seal the tube at one end by slowly rotating it over a gas flame until it is completely closed. Chemical supply houses or neon sign companies carry such tubes in stock — be sure the tube you buy is strong enough to hold the weight of the mercury.

The mercury container, into which the tube dips at its lower end, is called a cistern. Actually, it is a strong glass bottle about 3" long and of 1" inside diameter, although its size is not critical. The cistern slides vertically through a hole cut in a wooden block about ¾" thick and fastened to the support with long wood screws. The top of the block should be about 4" from the bottom of the support. The size of the opening in the block will depend, of course, on the outside diameter of the cistern, as shown in part B.

The bottom of the cistern rests on a bolt which threads into an L-shaped metal support about an inch wide, that can be made of ¼" brass or other materials. The bolt may be turned with a knurled knob or wing nut soldered on its lower end. The length and size of the bolt may be whatever is necessary to permit varying the height of the cistern by turning the bolt. Clamp the vertical glass tube to the support board by running it through two split blocks of wood, drilled to a size to accommodate the outside



diameter of the glass tube, as shown in part C of the diagram.

A small piece of thin sheet iron, pointed and shaped as drawn in part B, is fastened to the board with its point extending into the cistern.

The height of the mercury in the column is determined by fastening a section of ruler, at least 7" long and marked to tenths of an inch, alongside the tube (part A). Fasten the ruler to the support with two wood screws, but the screw holes should be slotted so slight adjustment of the scale is possible. The inch marks on the ruler should be numbered as shown in the drawing, if you are observing in a region near sea level, where the average pressure is taken as *29.92* inches. At greater altitudes, there are two procedures possible. The scale may be marked to range about the average pressure for that altitude (1,000 feet, *28.86* inches; *2,000, 27.82*; *3,000, 26.82*; *4,000, 25.84*; *5,000, 24.90*; *6,000, 23.98*; *7,000, 23.09*; *8,000, 22.22*); or the pressure reduced to sea level may be read directly by shortening the entire instrument to correspond to the difference between your altitude and sea level. The important thing is to

have any particular division on the scale the proper distance from the point of the metal tip. For example, in a sea-level barometer, the 30" division must be exactly 30" above the metal tip of the pointer. Then the barometric pressure will never range beyond the limits of the scale, as shown in part A of the diagram.

To assemble the barometer, first put about an inch of mercury in the cistern. Take great care not to lose any of the "slippery" mercury, working over a large basin or enameled vessel to catch escaping metal. Next, invert the glass tube so its open end is upward, but hold it at an angle so the mercury does not break the sealed end while you are filling the tube. A very small funnel is probably essential to proper completion of the filling operation. Tap the tube while filling it to drive out air bubbles. (Some writers recommend heating the mercury to dry it and drive out moisture and fine air bubbles, but this more difficult procedure need be done only in the interests of greater accuracy. It must be performed in the open air because of the highly poisonous mercury vapors.)

When the tube is completely filled, take a strip of heavy rubber about ½" wide and 8" long (a piece cut from an old inner tube will do) and draw it tightly over the open end of the tube. Invert the tube and lower the open end into the cistern, still holding the rubber strip tight to prevent escape of the mercury. When the end of the tube is well below the mercury level in the cistern, pull out the rubber strip. You can now clamp the tube to the support. The mercury will fall in the tube until its weight balances atmospheric pressure, forming a vacuum at the top of the tube. You may remove a little of the metal in the cistern with a small nonmetallic spoon or a paper scoop.

In reading the barometer, the thumb screw which supports the cistern is turned until the metal point rests on top of the mercury in the cistern. The height of the mercury (barometer reading) is then read off the ruler. Sea-level and temperature corrections may then be applied.

AMS MEETINGS RECORDED

Members of the local branches of the American Meteorological Society who are unable to attend national meetings will soon be able to hear, by means of recordings, papers that have been presented. A wire recording was made of a part of the meeting in Philadelphia in September. Previously, disk recordings were made of the paper presented by Professor Hurd C. Willett, "Patterns of World Weather Changes," at the 98th national meeting in April.

Eventually these recordings will be circulated among all the local chapters. There are now 27 branches of the society, including one in South America and a new one at Guam.

Plans are being made for the 101st national meeting of the American Meteorological Society to be held in New York City, January 25-28, with the Institute of Aeronautical Sciences.

THE CAPE COD WIND-INDICATOR
tells you the wind direction on a dial indoors —
It's the newest home weather instrument!

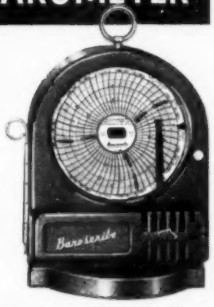
$39.95
postpaid

The vane, on your roof, flashes the wind direction to you **indoors**, by lighting the letters on the decorative black and gold dial. It plugs into regular house current (AC), costs less to operate than an electric clock. Fully guaranteed, easily and quickly installed, complete with 50 feet of wire. Send for yours today!

Send check or money order to:
CAPE WIND-INDICATOR
Kildee Hill Rd., Harwichport, Cape Cod, Mass.

Recording **BAROMETER**

- **Writes Easy-to-Read Continuous Seven Day Record on Replaceable Paper Chart**
- **Indispensable for Accurately Predicting Approaching Weather**



Here, for the first time, is a recording barometer at a price that is only a fraction of the cost of any other recording barometer ever made! The unique new BAROSCRIBE writes a continuous seven day record which shows time, magnitude, and rapidity of changes in barometric pressure. Such information enables you to forecast approaching weather conditions with a professional weatherman's high degree of accuracy. No need to watch barometer for several hours or set pointer. Record is also very useful for making day-to-day comparisons.

Price—$58.00, including 2 years' supply of charts and ink. Fully guaranteed. A companion temperature recorder is available at $35.00.

Sold by Leading Sporting Goods and Optical Stores, or Direct.

BACHARACH INDUSTRIAL INSTRUMENT CO.
7000 BENNETT STREET • PITTSBURGH 8, PA.

CLIMATE OF KANSAS

S. D. Flora. U. S. Weather Bureau, Topeka, Kansas, 1948. 332 pages. Free.

THIS REPORT, No. 285 of the Kansas State Bureau of Agriculture, was prepared by or under the direction of the section director of the U. S. Weather Bureau. It is an excellent presentation of climatic data, valuable not only to people interested in Kansas but to those interested in regional climatic studies. The preface states that it was inspired by Visher's **Climate of Indiana.** Twenty thousand copies were printed (paper bound) and its distribution within the state and to especially interested people elsewhere is free.

The first 60 pages consist largely of maps, analytical tables and diagrams of precipitation, based on the entire record. These include totals in 24 hours, the frequency of specified monthly totals, averaged by counties in a dry year, in a wet one, and normally. The next 60 pages consist of tables, for representative stations, of the monthly and annual precipitation for 1931-1946. Then comes a discussion of some notable dry periods in Kansas. Humidity is presented with the help of reprints of the maps for the United States from the Department of Agriculture **Yearbook for 1941,** "Climate and Man," with the boundary of Kansas blackened.

Temperature is discussed on pages 148 to 222, of which 40 pages are tables for selected stations. Dates of killing frosts, the length of the growing season, and sunshine and cloudiness each receive 10 pages of maps. Wind direction and velocity are presented partly by maps of the United States. Winter storms of unusual severity receive special historical discussion. Effective summaries are presented in a few pages each for tornadoes, hail and dust storms. The data on floods occupies 17 pages, including tables for individual stations. The last 30 pages of the volume consist of three articles by experts: on crop production and climate, on climate and insects, and on temperature and water supplies, especially their fluctuation.

This volume is a real credit to Kansas, to Section Director Flora, and to the many faithful observers and others who made it possible.

STEPHEN S. VISHER
Indiana University
Bloomington, Ind.

Here's a chance for every amateur weatherman to add to the accuracy of his hobby! WINDIKATOR—a *precision-built,* pocket-size anemometer—gives exact wind direction, wind velocity at a glance!

Non-magnetic, rust and corrosion resistant, WINDIKATOR is guaranteed accurate. Leather belt carrying case available. Model A indicates velocity 5-30 MPH, Model B, 10-60 MPH. If your dealer can't supply you, write Dep't. W-12 . . .

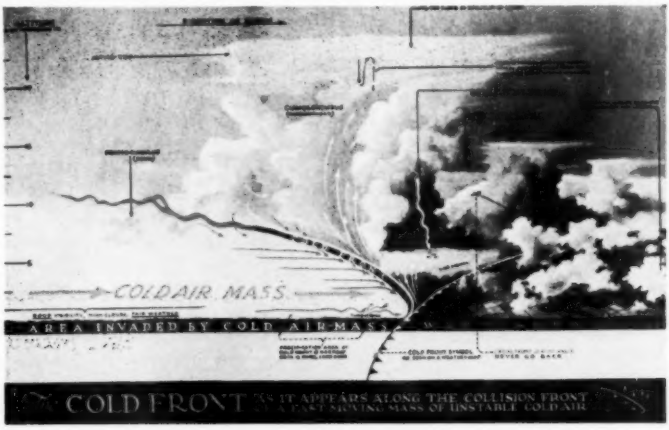
The H. M. SAWYER & SON CO.
Cambridge, Massachusetts

MIDWINTER TEMPERATURE ANTICS IN THE BLACK HILLS

(Continued from page 127)

temperature was between 5° and 10° below zero, which was expected. About half way south, the windshield of the car frosted so suddenly and so heavily that I was well toward the ditch before I could stop. When I got out of the car to clean the windshield, it felt like a warm, spring day with about 15 miles of southwest wind. At the station the temperature was 45° and the wind 44 m.p.h. west-southwest, with rain showers. As there was no extra thermometer at the station, I took the operator who had just gone off watch and returned to St. Onge, where I had a glass chemical centigrade thermometer which I knew was reasonably accurate.

We left St. Onge again about 9:15 a.m., and the indicated temperature was then —18° C. or zero Fahrenheit. In the next two miles the temperature rose slightly, but in the following ¼ mile it rose to —13°.0. This distance is in a creek bottom from 20 to 50 feet below the surrounding land. In the next 200 to 300 feet the windshield frosted as it had before. We got out to clean it, and from tracks in the snow found that we were only 10 feet from where I had stopped an hour before! The thermometer read 9.8° C. or 50° F. We had come up about 20 feet out of the creek bottom. There was a line of white, thick stratus following the creek, the tops from 100 to 150 feet above the surface, with heavy blowing snow from the northeast. The wind was about 30 miles per hour from the southwest where we were, only ¼ mile away.



Eric Sloane Is Painting Again!

Now he has created a set of weather murals ideally suited for classroom teaching or museum display. Each is a fine photographic enlargement, 39" high by 60" wide, of an original Sloane oil painting. It is large and readable, light and portable, mounted on sturdy Homosote board. Only $50.00 each.

WEATHERMURALS by Eric Sloane

1. The Cold Front
2. The Warm Front
3. A Cross-section of a Hurricane
4. The Atmosphere
5. The World of Clouds
6. The Effect of Altitude

For full information, write or visit

ERIC SLOANE, WEATHER HILL STUDIOS, ROSLYN, L. I., N. Y. Brookville 5-1786-J

For Christmas

Give a membership in the AMATEUR WEATHERMEN OF AMERICA, which includes a subscription to WEATHERWISE. Membership costs $3.00 a year in the United States, plus 50 cents for Canadian and Pan-American postage, and $1.00 for postage to foreign countries.

Volume 1 of WEATHERWISE is much in demand, but copies may be ordered in the complete set of our first six numbers, at $2.00 per set, or individually at 35 cents each postpaid. Use the order blank below.

AMATEUR WEATHERMEN OF AMERICA
The Franklin Institute, Philadelphia 3, Pa.

☐ Enter a membership in the Amateur Weathermen of America for the year 1949 for the person whose name and address are given below. I enclose $..... for this membership.

☐ Send the following numbers of WEATHERWISE for 1948: February, April, June, August, October, December. (Cross off months not desired.)

☐ Send a complete set of WEATHERWISE for Volume 1.

Enclosed is $..... to cover the above order.

Name: .....

Address: .....

City ..... Zone ..... State .....

Please send (do not send) a gift card in the name of .....

Donor's address is: .....

Symbol and Source

of America's
foremost
weather instruments

Bendix-Friez Hygro-Thermograph

The Bendix-Friez Hygro-Thermograph model 594 records relative humidity and temperature simultaneously on one chart. The precision of this fine instrument derives from the humidity sensitive unit composed of a multiple strand of specially treated human hair and the temperature responsive bourdon tube, highly polished and gold plated. Both functions are transcribed by lever activated recording pens. The vertical chart cylinder is rotated by a fully jeweled mechanism with interchangeable gears available for either daily or weekly operation.

Portability, precision construction and ease of operation have combined to make the Bendix-Friez Hygro-Thermograph a leader in the field of recording instruments.

FRIEZ INSTRUMENT DIVISION
OF BENDIX AVIATION CORPORATION
Baltimore 4, Maryland